sphere on the exit side there was a cooling effect of 0·2 Cent. The steam, therefore, issued at a temperature above 100° Cent., and, consequently, *dry*; showing the correctness of the view which we brought forward some years ago * as to the non-scalding property of steam issuing from a high pressure boiler.

II. "On the Bromide of Titanium." By F. B. DUPPA, Esq. Communicated by A. W. HOFMANN, Ph.D., F.R.S. &c. Received February 14, 1856.

A comparison of the boiling-points of corresponding chlorine and bromine compounds, led Prof. Kopp to the interesting discovery, that on the average their boiling-points rise 32° C for every equivalent of bromine which is substituted for an equivalent of chlorine.

	Boiling-point.	Difference.
Chloride of ethyl, $C_4 H_5 Cl$	11° C.	30.
Bromide of ethyl, $C_4 H_5 Br$	41° C.	
Dichlorinetted ethylene, $C_4 H_4 Cl_2$	67° C.	$66=2\times33$.
Dibrominetted ethylene, $C_4 H_4 Br_2$	133°·6C.	
Terchloride of phosphorus, $P Cl_3$.	78° C.	$97=3\times32\frac{1}{3}$.
Terbromide of phosphorus, $P Br_3$.	175° C.	

If this difference be constant for all chlorine and bromine compounds, it becomes obvious that very important inferences in respect to the atomic constitution of these substances may be derived from the determination of their boiling-points. This result has, in fact, been happily applied by Prof. Kopp, as a criterion to determine the equivalent of silicium, a matter of such uncertainty as to have led to the admission of not less than three formulæ for silica—

$$SiO$$
$$SiO_2$$
$$SiO_3.$$

From the difference between the boiling-points of chloride (59° C.)

* See letter from Mr. Thomson to Mr. Joule, published in the Philosophical Magazine, Nov. 1850.

and that of bromide (153° C.)—a difference which amounts to $94 = 3 \times 31\frac{1}{3}$—Kopp derives the formulæ

$$SiCl_3 \text{ and } SiBr_3,$$

as representing the atomic constitution of the chloride and the bromide of silicium, and he accordingly fixes the equivalent of silicium at 21·3.

In order, however, to prove the general validity of Kopp's observations, it was necessary to re-examine the boiling-points of corresponding chlorine and bromine compounds which exhibited discrepancies, and to extend the inquiry to as great a number of new compounds as possible.

Mr. Francis Baldwin Duppa has, at my suggestion, undertaken an investigation of this subject, and has already obtained some valuable results, whieh I beg to communicate to the Royal Society.

The bromine-compound of titanium was unknown. Mr. Duppa has produced this substance by passing a current of bromine over an intimate mixture of pure titanic acid and carbon. The reaction takes place at a bright red heat, and furnishes a brown liquid, which solidifies in the receiver to a crystalline mass. Distilled with an excess of mercury, which removes any free bromine that may be present, the bromide of titanium presents itself as an amber-yellow compound, exhibiting a magnificent crystalline structure; it attracts moisture with the greatest avidity, and is converted into titanic and hydrobromic acid. Bromide of titanium has a specific gravity of 2·6. The fusing-point was found, 39°. The boiling-point was examined by Mr. Duppa with a considerable quantity of substance, the purity of which had been ascertained by analysis. It was observed to be 230° C. The boiling-point of the chloride of titanium, as observed by Dumas, and confirmed by Mr. Duppa, is 135°. The difference, $230 - 135 = 95 = 3 \times 31\frac{1}{3}$, is exactly the same as that observed between the boiling-points of chloride and bromide of silicium.

This observation furnishes an additional support to the analogy of silicium and titanium, while it points unequivocally to the formulæ

$$TiCl_3 \text{ and } TiBr_3,$$

as representing the atomic constitution of these two compounds.

Titanic acid, hitherto universally represented as a binoxide TiO_2, would then assume the formula

$$TiO_3$$

in perfect analogy with that of silicic acid.

The equivalent of titanium would then be changed from 24·29, the number at present adopted, to 36·39. The protoxide of titanium would in this case become a sesquioxide, and the compound hitherto viewed as sesquioxide would have to be considered as an intermediate oxide—as a combination of the sesquioxide with the teroxide, in fact, as a bititanate of sesquioxide of titanium.

Formulæ of the Titanium Compounds.

Old Notation.		New Notation.
$Ti = 24 \cdot 29$		$Ti = 36 \cdot 39$.
$Ti\,O$	First oxide	$Ti_2\,O_3$
$Ti_2\,O_3$	Second oxide	$Ti_4\,O_9 = Ti_2\,O_3,\ 2TiO_3$
$Ti\,O_2$	Acid	$Ti\,O_3$
$Ti\,Cl_2$	Chloride	$Ti\,Cl_3$
$Ti\,Br_2$	Bromide	$Ti\,Br_3$.

It is scarcely necessary to observe, that an alteration of the equivalent of titanium on the ground of the difference of the two boiling-points, would be hazardous, if not supported by additional experimental evidence, and that further researches on the series of titanium are required in order to establish whether the proposed alteration actually affords a simpler expression for the combining relations of this remarkable element.